Agenda Item D-3

40th Argos Operations Committee meeting
Prepared by CNES
May 24th, 2006

System Performance

1- System Occupancy

The following figure provided by CLS presents the System Occupancy (as seen by users) in Erlangs.

The definition of Erlang is recalled below :
Erlang : a dimensionless unit used to denote system traffic flow over a given time period.It expresses the ratio (time during which system is busy)/(time during which the system is usable).It may be greater than one if the system supports simultaneous access.

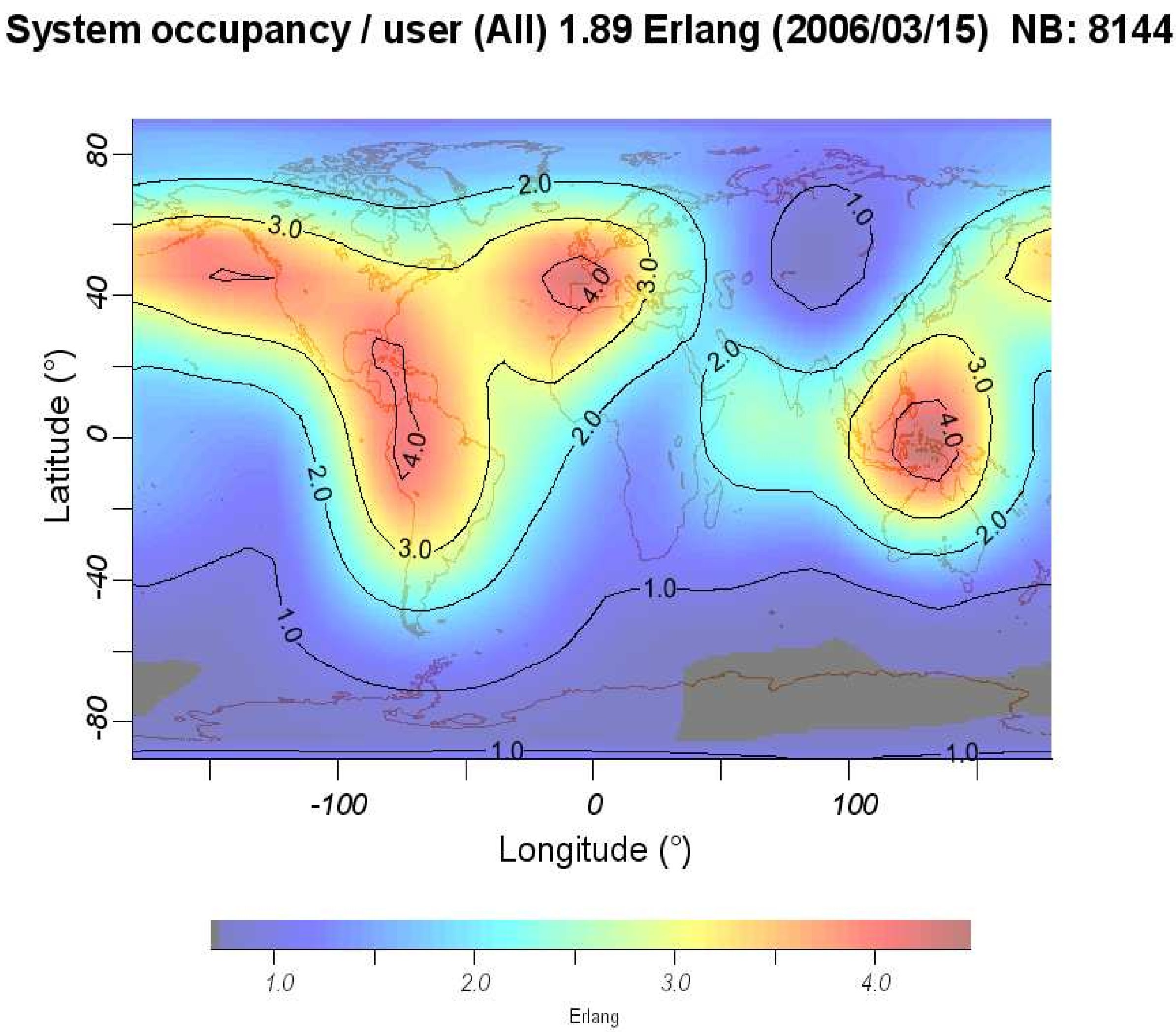

Figure 1 : System occupancy (as seen by the users) in Erlangs

The following figure provided by CLS presents the System Occupancy (as seen by the satellite) in Erlangs.

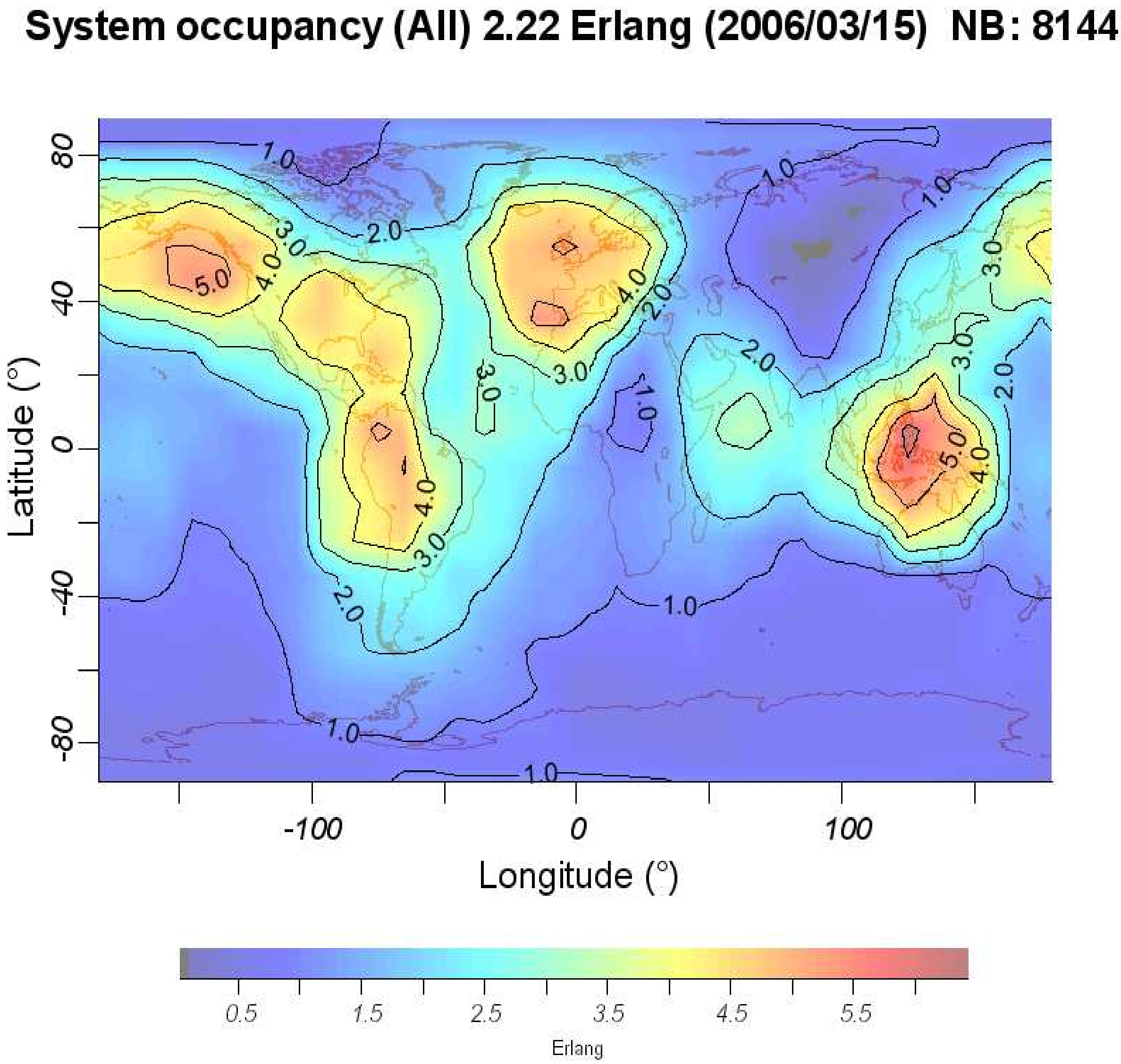

Figure 2: System occupancy (as seen by the satellite) in Erlangs

The figure 2 shows that a density higher than 5 is achieved in several areas leading to an elementary probability of 80% for a single message burst to be received and processed on-board the instrument.

The figure 3 presents this elementary probability to receive correctly a single Argos message versus the beacon traffic and for the different instruments.

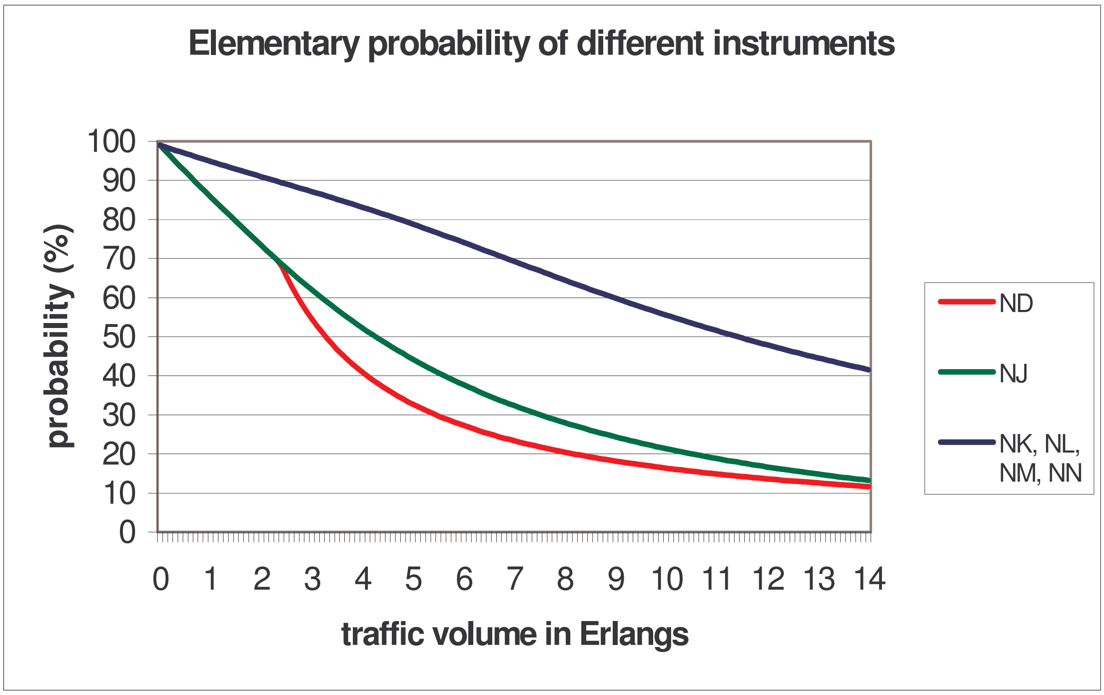

Figure 3: System occupancy (Erlangs) / probability of successful reception transformation function, for a given satellite.

Satellites ND and NJ are first-generation satellites (Argos-1). Satellites NK, NL, NM and NN are second-generation satellites (Argos-2).
ND and NJ perform identically up to a volume of 2.5 Erlangs. At higher volumes, ND's slower telemetry rate puts it at a disadvantage.
The curves for NK, NL, NM and NN are identical.
These curves apply where signals received are spread over a bandwidth of 24 kHz for Argos-1 and 80 kHz for Argos-2 at satellite antenna.

The result of 80% (for Argos-2 instruments) is theoretical since it assumes that all the beacon frequencies are uniformly spread over the 80 kHz Argos-2 bandwidth. But as there are still two operational Argos-1 instrument and a reduced bandwidth (24 kHz) and also because there is an important inertia on the beacon frequency spreading, the result is certainly much lower for all beacons transmitting in the bandwidth 406.050 MHz +/- 5 kHz (see figure 4).

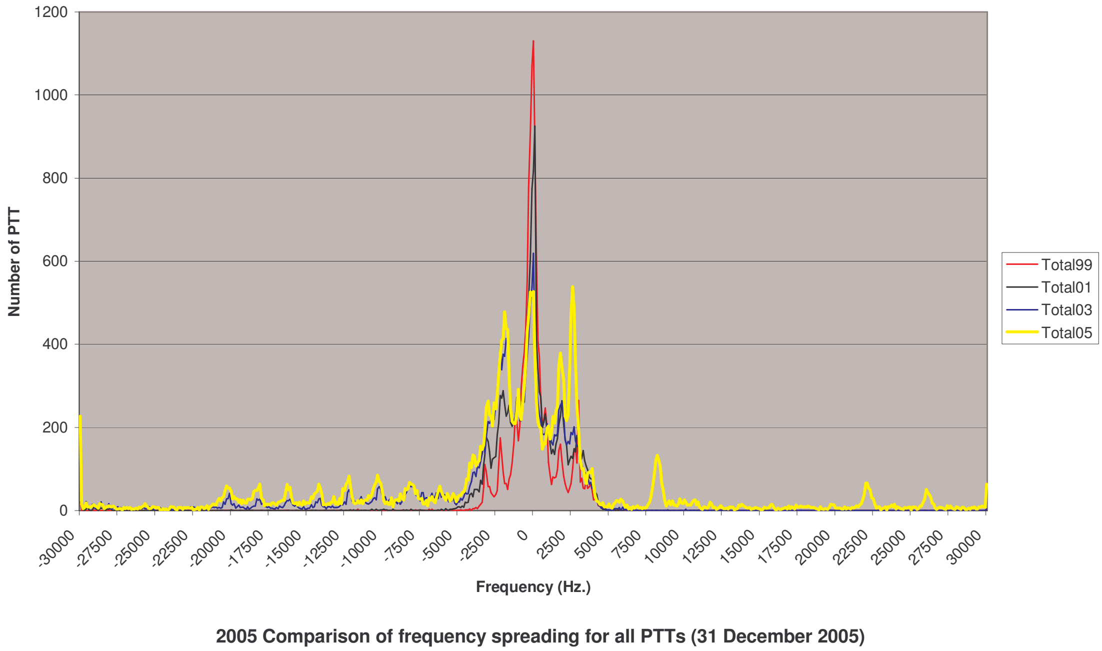

Figure 4: Frequency spreading for all platforms (years 1999, 2001,2003, 2005)

2- Latency

This parameter is expressed as a distribution function: for a transmitter at different latitude, from the Equator to the pole, by a 10-degrees step in latitude, the curve shows the probability that the transmitter will be received after a certain time delay (expressed in hours). The probability of the latency being of the order of 30 minutes is 35% for a transmitter at the Equator. The average latency is less than 1 hour 30 minutes 87% of the time, irrespective of the transmitter's geographic position

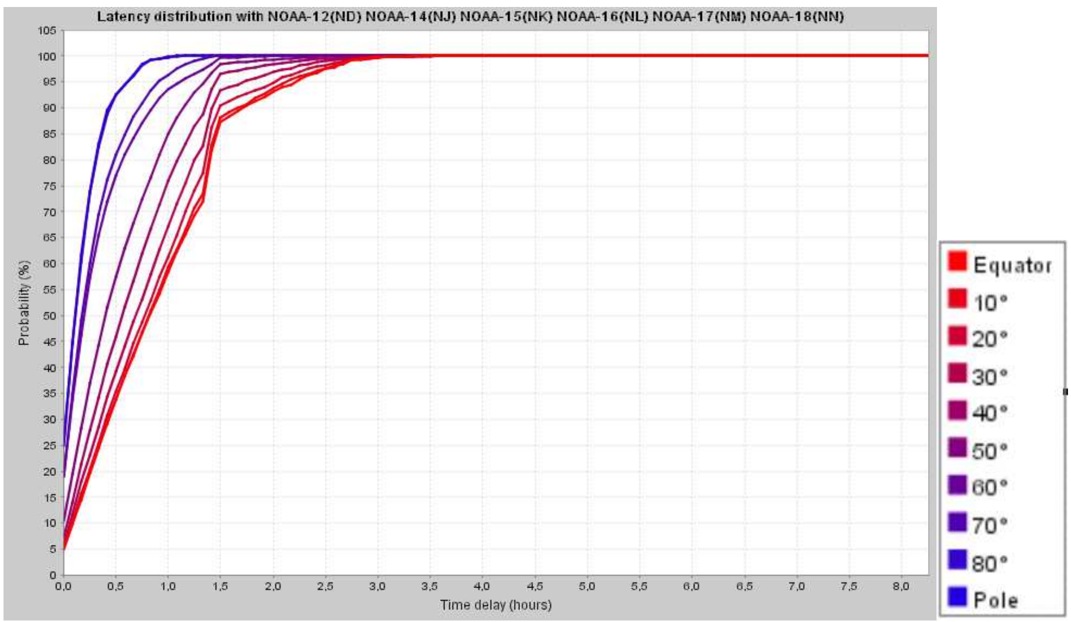

Figure 5 : Latency for transmitter reception by a satellite in the current constellation.

3- Interferers in the Argos band

From several months, it has been observed by CNES and by CLS above Europe (mainly above Mediterranean area and Central Europe) a degradation of the Argos performance mainly for the beacons having a low transmitted power (< 1 Watt).

The following figure shows that the "European threshold" is at -130 dBm (see figure 6) and doesn't allow a nominal reception of beacons with an output transmitted power of 125 mWatt or 250 mWatt as it is currently used for animal tracking applications for instance. In this part of Europe, the correct reception of beacons is possible only if their transmitted power is > 1 Watt (note that this power of 1 Watt is the nominal value required for the Argos beacons).

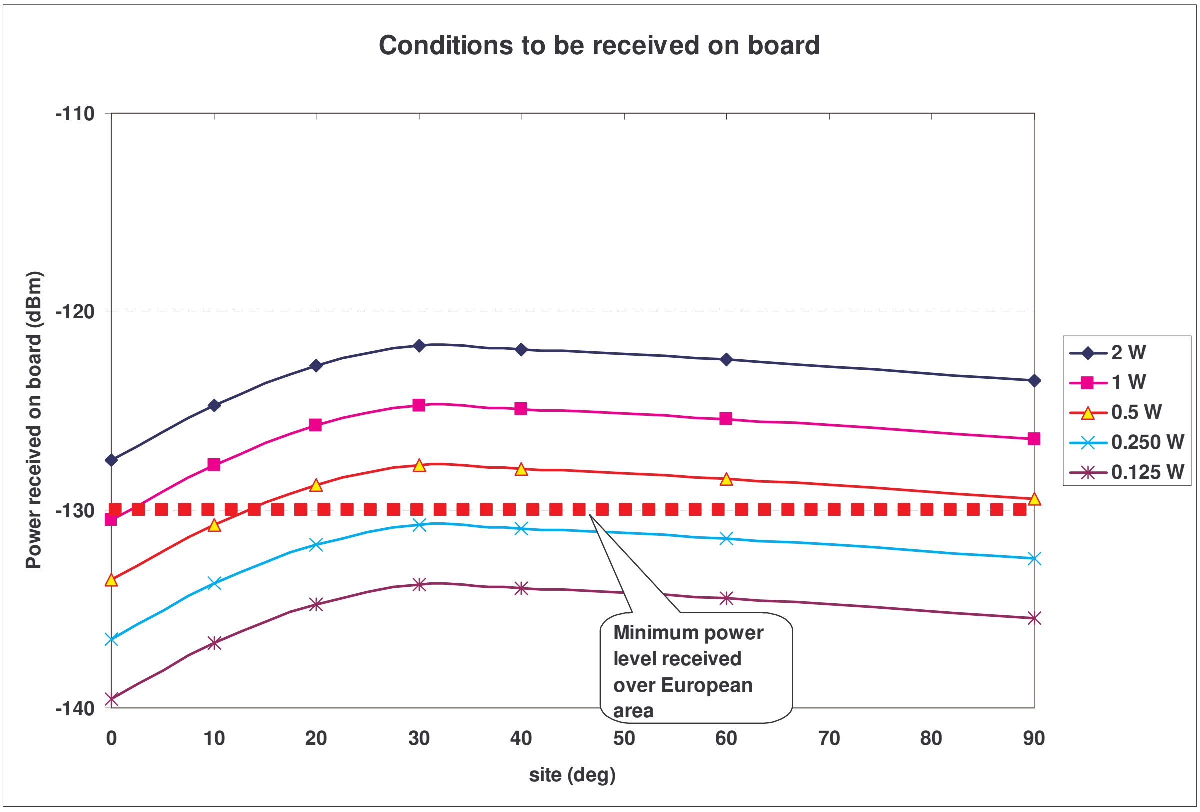

Figure 6 : Conditions to be received on-board versus the beacon output power.

As the beacon density is roughly the same (around 5) in Europe than in North America or in South-East Asia (see figure 1), it is assumed that the increase of total signal is due to an increase of noise. This noise can be issued from several sources (wide-band noise, industrial noise, narrow-band interferers, etc..).

Through the “pseudo-message” function activated on-board NOAA-16 on January 2006, the SARP-2 instrument is now processing narrow band signals received in the Argos bandwidth, to perform time and frequency measurements and then to provide specific messages which are included in the Argos mission telemetry. At ground level, these pseudo-messages are processed and specific algorithms are used to provide location by extracting Doppler curves.

The following interferers have been identified from January to April 2006.

Ident	Country	Longitude (°E)	Latitude (°N)	approx. Tx Frequency (/401.65 MHz)	Power Level (dBm)	Location accuracy (km)
ALG001	Algeria	6.0800	31.6327	22700	-116.00	12.80
ITA001	Italy	10.1207	44.7937	-39000	-130.00	56.86
ALB001	Albany	20.2944	40.5871429	0	-105 to -120	60.43
SYR001	Syria	36.2677	33.54556	-22500	-119	7.25
EQU001	Equator (North))	281.3558	-0.2226	-1000	-120.00	5.03
EQU002	Equator (South)	281.1315	-0.8542	-3000/-500/2000	-130 to -120	21.00
RUS001	Russia (East)	74.5886	60.6660	25000	-115 to -105	83.04
RUS002	Russia (West)	40.6137	64.5510	-30000/-13000	-125 to -116	82.93

Nota : the mean location of the interferer is obtained by averaging all the available locations of the interferer.

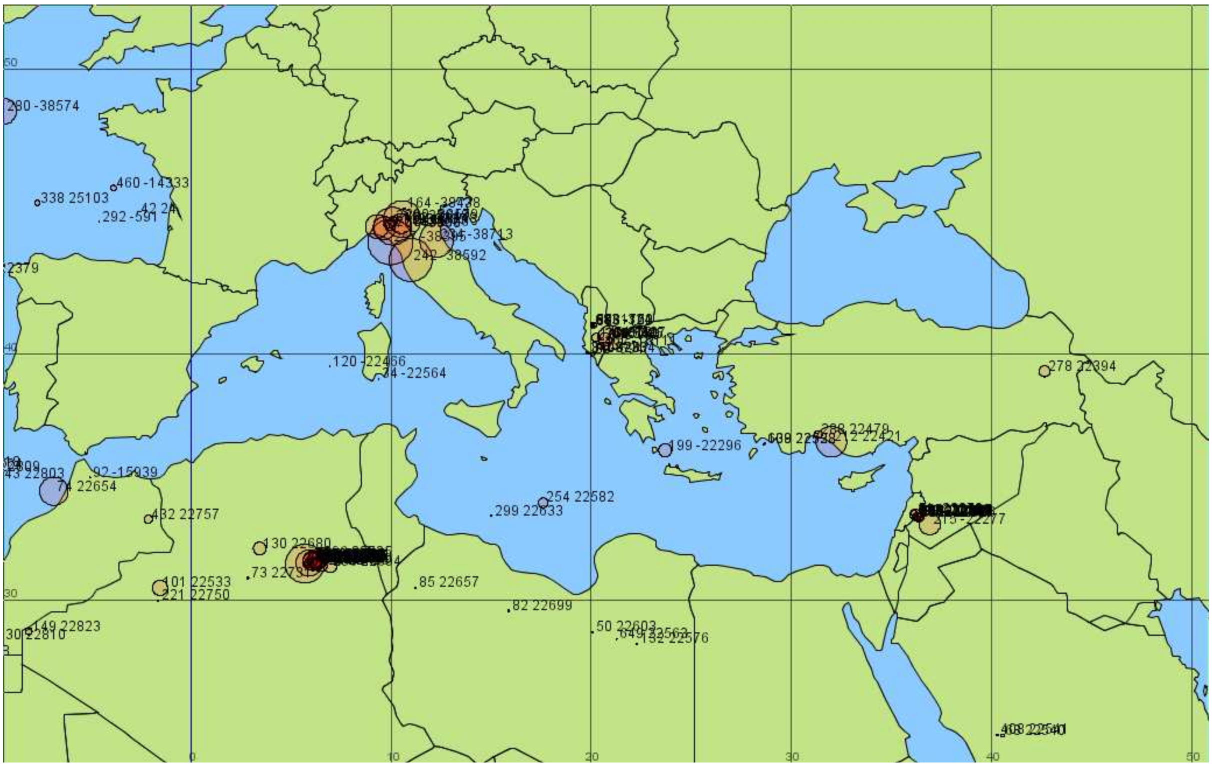

Figure 7 : Location of interferers in South Europe.

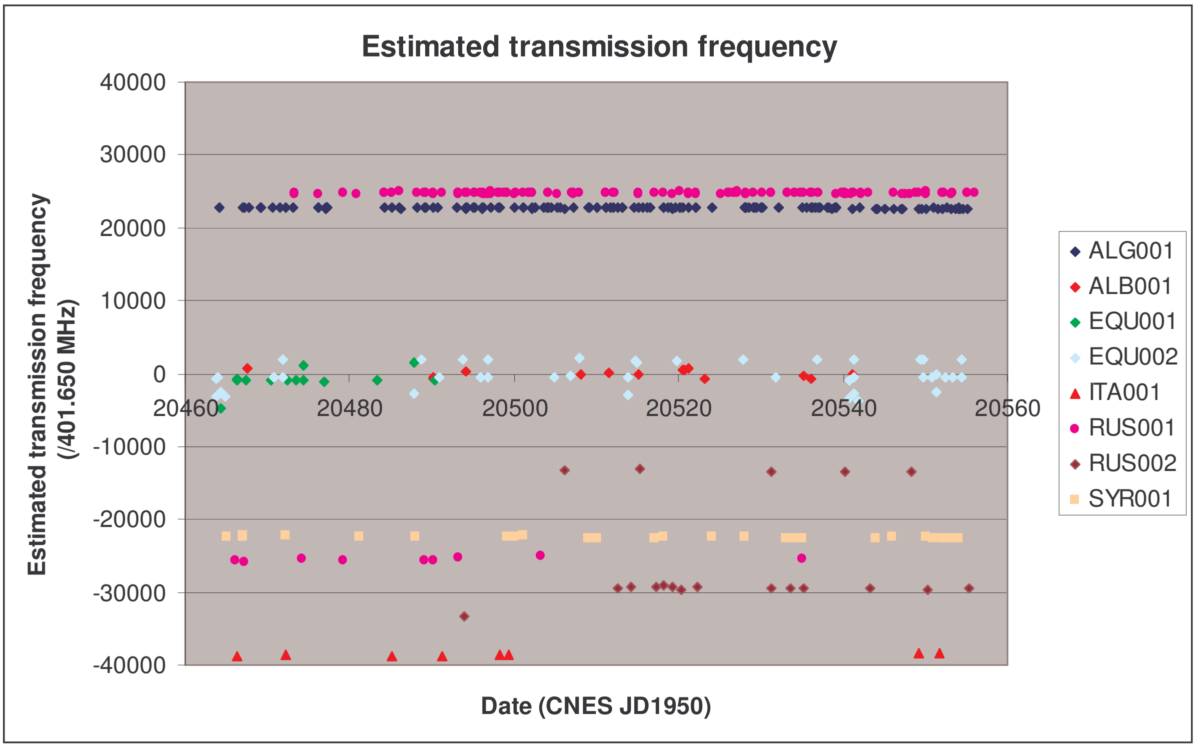

Figure 8 : Estimated transmitted frequency of interferers.

Some specific Frequency Regulation actions have been taken at CNES level through the CNES Frequency French Bureau in order to send corresponding frequency complaints reports to ITU. The hope to have these interferers switched-off by their respective national Administrations stays very limited.

It has to be noted that the “pseudo-message” function doesn’t allow to detect and to locate the “wide-band interferers” and also that the transmission conditions in the Mediterranean area should stay identical in the next months, even if a few “narrow-band” interferers are switched-off.

The NOAA-16 DCS instrument continues to nominally process the Argos messages and to provide the corresponding Telemetry.

For the time being, we propose to stay in the current satellite configuration (pseudo-message mode on NOAA-16 only and nominal mode on the other satellites).

4- Argos-3 System Performance

The third generation of Argos instruments should improve a lot the Argos system performance mainly through the downlink and the new high data rate platforms.

CNES, in charge of the in-orbit validation, will perform some exhaustive tests in order to measure in detail the performance of the new system and to compare it to his theoretical models. In collaboration with CLS, some platforms representing different typical Argos applications will be deployed in several environmental conditions and will be monitored in detail. These platforms will be used within different modes in order to test as far as possible the performance and the capacity of the new system. All communications managed by the platforms and by the Argos instrument on the uplink and the downlink will be stored, acquired and processed by CLS and CNES.

The Argos-3 in-orbit validation phase will last roughly 6 months after the Launch and the “demonstration PMTs” will be monitored until mid-2007.

The results obtained during this phase will serve as inputs for establishing the financial model for the Argos-3 usage.

CNES plans to report on these Argos-3 system performance at the Opscom 41 in June 2007.